UiA University of Agder

Bachelor

Epistemology of measurement in non-human animal consciousness

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Introduction

In this essay I am going to argue that factual claims and a normative claim for non-human animal consciousness are not mutually exclusive. The factual claim follows that: Animals with a high level of consciousness are those living beings which are more highly dependent on their materialistic ecological circumstances than those with less cognition. The normative claim is this: Given the factual claim, humans are not justified in treating non-human animals as being of any lesser value than human beings. My historical judgement on humans follows from the normative claim, yet I will primarily focus my text on the factual claim as my normative claim is representationally naturally implied by my factual claim.

It seems to me this implication is convoluted by at least two factors. Firstly, the science of animal cognition has bearings on the core foundations of the scientific method itself. Secondly by a very real sense, nature has clear rules by which it operates and functions, these rules and laws are obeyed on cosmic, terrestrial, biological and subatomic scales. The three main branches of physics namely: Newtonian Mechanics, Quantum Mechanics, and Statistical Mechanics (Thermodynamics) dictate and restrain the possible outcomes of any measurable observation that humans can achieve.

Among the many obstacles set forth by science against its ability to make truth statements about consciousness, is *Cartesian Dualism.* It is responsible for our past collective inability to deal with the *Mind-Body Problem* adequately. Alongside is also the accepted characterization of objective facts, and rejection of *Metaphysics* which is a sign of *Logical Empiricism*. In science therefore, conceptual normative arguments which actually lack empirical data are employed to deny animals a legal moral status and mental states. This results in few philosophers upholding any empirical data for consciousness as being key to argue for the justification against animal rights. Albeit this situation, animal cognition is seen by most scholars to be an integral part of commonly held views in *Philosophy of Mind*, *Metaphysics* and *Epistemology*. Regardless of epistemic support, for or against the moral status or mental states of animals, *Quantum Mechanics* without question seems to break some fundamental principles of *Classical Physics* and of our true perception of reality. This leads to a situation whereby human perception of reality is seen as being objective and determined, while actually the true nature of the quantum realm is indeterminate and violates any observational certainty.

The present situation in human-animal affairs has recently remarkably changed as of early 2022. Ecuador, as the first country in the world, has granted animals rights in their "rights of nature" provision in their national constitution. Until this ruling, legal cases in the field of non-human animals rights have mostly focused on environmental law and protection of ecosystems and species and not on rights for individual animals. The Courts recognized animals as: "subjects of rights", not only through the "rights of nature", and clearly set forth rights that apply to most animals. Strikingly, paragraph 121 of this law reads that animals have a *"Right to demand their rights from the competent authorities".* For what it's worth, it now tseems as human ignorance and unwillingness to grant animals rights is under epistemic attack.

The 2012 "Cambridge Declaration on Animal Consciousness", also implies an agreement that; *"The weight of evidence indicates that humans are not unique in possessing the neurological substrates that generate consciousness."* Still however, not all philosophers of mind regard the matter as fully resolved, writing that: *"The mystery of consciousness remains. The explanatory gap is as wide as ever and all the wanting in the world will not take us across it"* (Dawkins, 2012: 171-172).

The implication of my study is complicated by the fact that natural sciences have not yet accounted for a valid theory of consciousness. Much of the problem arises from ontological arguments about the nature of relations between the physical body and mental mind.

Hence, it is required of us that we thoroughly investigate what measurement really means for our knowledge (Mari et al. 2021). On the one hand, consciousness may be a monistic fundamental constituent, indivisible and universal yet forever empirically untestable. On the other hand; a dualistic approach, as the accepted mainstream view in psychology, concludes that the mind is abstract and immaterial, forever detached from the body yet not disconnected from its underlying material foundation. As such, a reductionist approach to describe; if consciousness is the fundamental object of the physical, but not reducible to any other physical principles or quantity remains an open question, but it does not offer us a basis on which we can deny an ontological premise for conscious animals.

Let me address the latter complication first (in §1 below) before turning (in § 2 below) to the second and even more complex cumbersome issue of scientific measurability itself.

1 No adequate theory of consciousness

This study identifies Aristotle and Descartes as having very differing views as to the level of perfection that humans enjoy above animals, either view is commonly used as justification for the claim that animals have an inferior moral status to that of humans. Rene Descartes (1596-1650), argued; that it is possible to deny animal consciousness as animals mechanistically can be described as *automata*, beings that act as if they are conscious, but in fact are not (Singer and Regan, 1989: 13-19). The ethical ramifications of Descartes logic; that it is acceptable to eat animals because they do not possess the capacity to feel and think is rooted in his view that such behavior requires sense perception and a thought process. Descartes, despite being criticized in this regard, was in fact a vegetarian and was nevertheless disturbed by the issue surrounding sentience, because if animals feel pain, it must be wrong to kill them for food (Singer, 1975).

Accordingly; the need for an adequate explanation for animal minds has been hijacked by preferred explanations of parsimony when upholding psychological simplicity and mechanistic behaviors which don't require reference to an inner mental experience of animals. Thus, animal behavior, in Cartesian dualistic terms, is described as not presupposing the necessity of animal consciousness. The extraordinary suffering that has befallen the animal kingdom due to this logical inference is unbelievable.

Further complication in our study also arises from the Aristotelian refusal to ascribe rationality to animal minds. According to the book, “Animal Mind and Human Morals” (1993) by Richard Sorabji, the approach to viewing animals as irrational became a turning point between a differentiation of human and animal consciousness in the western world, one which largely has impacted ethical and moral considerations against the interest of animals. Concurrently, it is difficult to justify Aristotle’s treatment of the animal soul in “De Anima” as we foremost must deem it according to its premise of attributing irrationality to animals. Aristotle's denial of animal consciousness also removed recognition of social animals' ability to plan and communicate.

Our interest, despite covering different disciplines, ironically agrees with research on neural correlates of consciousness as a biological premise for explaining the mind-body problem by accepting the brain as a *Distributed Information-Processing System*.

Nevertheless, any quantification effort needs to be based on multiplicity of empirical structures and not only on arbitrary unrelated data which professes the objectivity of brain regions interacting and exchanging information through input and output signals.

According to John Searle's view, the mind-body problem is easily understood, *"Here it is: Conscious states are caused by lower level neurobiological processes in the brain and are themselves higher level features of the brain"* (Searle, 2010).

A biological and naturalistic understanding of non-human animal consciousness may be able to show; that there are fundamental measurable variables and correlations of perception that have emerged from the early era of phylogeny. Such a theory would have an operative assumption; that increasing biological and genetic complexity has yielded varying sensory perceptions and consciousness in many species distributed on a measurable scale.

When even thinking of conducting this research, we are faced with the obstacle of needing to attribute consciousness and self perception to the experience of both *Humans* and *Infrahumans* (A creature that is not (yet) at the level of understanding of a human being, such as a presymbolic child or an animal).

As I assume to begin with, animals with a high level of consciousness, are those beings which are more dependent on their materialistic ecological circumstances than those with less cognition. The most obvious support for this factual claim is the yet still unofficial unit of geological time named the *Anthropocene Epoch* demarcating human devastation of earthly resources, whereby there is no doubt which species on earth is the most materially dependent. Notwithstanding, we need to keep things quantitively in perspective. Of the 545.8 gigatons of biomass on Earth of which most is plants, animals make up 0.47% while humans only 0.01%, bacteria reigns supreme with 12.8% of total (WEF, 2021). Hence the American Pygmy Shrew for example is the smallest mammal in North America, but still manages to eat three times their own body weight daily due to their high metabolism and short lived but fast-paced life. Diminishing the role of bacteria in our research is hence not wise, the *Cellular Basis of Consciousness (CBC)* states that biological awareness and sentience originates in bio-sensitivity and is evolutionary foundational with consciousness grounded in cell biology (Baluška et al. 20121).

In support of my factual claims is quantitative research that henceforth has shown that ecological diversity has created sensory adaptations which manifest as varying temporal resolutions constrained by metabolic rate and body size; these effects are found across human and animal species. The disparity found in the data, between metabolic rates and body sizes, illustrates that different species occupy a wide range of multidimensional temporal and spatial niches. Such data points to the possibility of a theoretical capability, to encode and perceive information in environmental signals, in between species, and between animals and nature itself. Animals, like humans, consist of an incredibly large number of complex internal component parts which are interacting in a non-linear manner. How humans define and apply quantity-terms to measurable objects, depends on our own non-trivial choices in measurement methods.

Complex Systems Theory thus describes living beings as essentially open thermodynamic systems existing in a constant environmental energy exchange. Such internal biological structural dynamics, on small scales, can behave as self-organizational microscopic features which yield emergent macroscopic properties. In this essence, the matter of *Criticality* exposes those internal states which can experience spontaneous quantitative changes and fluctuations that happen at all scales of biology. Thereby, criticality as such enables a diverging of the length of statistical correlation and susceptibility of complex systems to external influences. These critical regularities, if adequately described, may offer us new ways of defining different levels of biological organization as *Universality Classes* which can pave the way for a multidisciplinary investigation of both human and non-human animal consciousness (Sornette).

Determinant factors for measuring sentience: Mathematical theories of (any type of) measurement, describe how scientists view the intersection of operational setup, theoretical language and our semantic understanding of the meaning or regulation of parameters as undergoing changes to our terminology of quantities. Holding a realist position on measurement, means to view it as approximative estimations of mind-independent (objective) properties and/or relations in the world which we can have knowledge about.

Accordingly, by setting forth a basis for empirical realism, a consequence arises whereby measurement becomes a non-representational event of mind-independent numbers (Michell, 2003).

Hence, to claim anything empirically about properties or relations, without presupposing some or another background theory, is impossible. Therefore, an exhaustive clarification on the *Epistemology of Measurement* has not yet been reached, but is a historic process which is still unfolding in *Philosophy of Science.* Increasing axiomatization of empirical structures is thus forthcoming in this research.

Measurement Theory thus argues; that the empirical basis for mathematical structures are those which mirror the relevant relations that exist among the measured objects i.e. confirming a correspondence theory of truth.

Naturally, there exist various theories which differ on what kind of necessary empirical conditions exist for quantification, and what kind of consensus on employed theories is necessary for an accurate classification of scales. We thus must ask what kind of data actually suffices to map out measurable attributes or relations between objects and numbers that brings about any theoretical consensus (Suppes, 1951).

According to Aristotle, there is a difference between how quantities can say something about equality or inequality (between objects), but can claim nothing about degrees (ratios of magnitudes). Conversely, he meant that qualities can clarify degrees of change, but can tell us nothing about equality or inequality. On this basis, it is stated in Gottfried Wilhelm Leibniz's (1646-1716) "Principle of Continuity" that; *"all natural change is produced by degrees"*. He thus argued: that this principle also applies to intensities of representational states of consciousness (Jorgensen 2009).

Hence, when dealing with measurement of psychometrics of human minds, criticism is directed against the presupposition that any successful quantification of psychological attributes is possible at all (Michell, 2003).

As animals seemingly do not display intellectual capacities, many therefore claim that a lack of animal consciousness is a valid argument for their lack of rights. Contrary to such arguments, we assume that distribution of consciousness can in fact be seen as alterations to an entropic equilibrium of a shared cognitive field obeying thermodynamic laws.

Such proposition also points to David Bohm´s ideas about a *Holographic Theory of the Universe*, wherein the "implicate order" offers a holistic cosmic view whereas everything is connected and in principle any individual element can reveal *"detailed information about every other element in the Universe"* (Peat).

However, if we logically state anything about any such possible coherence as a theory of truth, or correspondence between examined theories, our statement becomes a first-order empirical interpretation of epistemology of measurement, and a second order claim about possible universal ratios of magnitudes of animal consciousness.

2 Methodological intricacies

When discourse on other minds becomes evident, arguably the minds of other animals get sidetracked on the basis of more or less lack of observed similarities between physical features and/or behaviors of examined organisms (Sober, 2000; Farah, 2008). Thus for our analysis, it will be sufficient to identify the methodological shortcomings in measuring methods and normative errors in classification of degrees of distribution of consciousness. Hence our aim is not to explain what consciousness is or does per say, this position will naturally help us to minimize the scope of our investigation (Block, 2013).

My aim, therefore, is to look critically at the scientific methods employed in general.

Considering this critique, I shall argue that the issue of consciousness, in non-human animals, hence poses two main questions: the first entails the target of research; are there other animals than humans that are conscious, if so, then to what degree are they conscious? (The Distribution Question). The second question, which is outside of the scope of this paper, differentiates between knowing the mental state of others and if we can know what animal consciousness *is* like (The Phenomenological Question).

Darwin in his book "On the Origin of Species" wrote; *"It is a significant fact, that the more the habits of any particular animal are studied by a naturalist, the more he attributes to reason, and the less to unlearnt instinct"* (1871, Book I, p.46). Darwin indeed devoted much of his work to the obvious goal of demonstrating how mental continuity in fact exists among the species. Scientific experimentation about animal minds, due to their phenomenal nature, are nevertheless mostly not possible and very difficult to study. We could even say; that the topic is beyond the capacity of objective scientific methods (Nagel, 1974).

The Epiphenomenal Argument: Another question we also must raise; is if phenomenal consciousness is completely epiphenomenal with no causal influence itself on psychological behavior?

Borrowing theoretical grounds from computer science, and *Theory of Mind* (ability to see things from another´s perspective), the position of *Functionalism* argues that mental states are what they do, and not what they are made of which is the position of *Computationalism*. The latter argues the mind is an information processing system which describes the true nature of consciousness. In a computational sense, the overall function of the brain is to follow a casual phenomenon of computing information. This view has also had a tremendous negative impact on cognitive sciences and psychology yielding us as robots reacting to information (Miłkowski, 2013).

Functionalism argues for mental states in computer systems and their possible existence. Others like John Searle have objected to such beliefs and opposed the claim that computers have the intrinsic possibility to have mental states. The resemblance in this discussion, between possible mental states of computers, knowing other minds, and knowing the mental states of animal consciousness, thus are not only logically intertwined, but also presume a cross-disciplinary field of research.

The argument from functionalism would be that epiphenomenal experience is a physical occurrence, something that takes place in a temporal and spatial sense. The obstacles to explain qualia in the philosophical mind-body problem, and the so-called *Hard Problem of Consciousness* in psychology, thus boils down to our inability to ascribe different functional roles to different qualitative mental states. However, functionalism exhibits vulnerability to the Chinese Room argument, a topic we will return to later (Block, 2013; Maudlin, 1989).

The Teleological Argument: Aristoteles said that animals have a "telos", a purpose, and a goal, and indeed for some animals, their goal was to become our food, for better or for worse. The purpose originated in a first initial cause, the simplest original form of consciousness or agency. Teleology, as that proposed by Thomas Nagel, imply that scientific theories of evolution factually can include teleological laws as explanations of consciousness, life, and rationality (Bruce).

Returning to Searle, we find a particular distinction being made *"...between the original or intrinsic intentionality of genuine mental states, and the derived intentionality of language".* Thus we encounter the obstacle of measuring fundamental units of intentionality.

As John Searle settled correctly, we can only grasp intentionality in other mental states if we are faced with a written or spoken language coming to us from another's mental state.

The difference between “original intentionality” and “derived intentionality” is according to Searle; that the former has the potential of being self-conscious. Searle clarified; that there is a wide explanatory gap between our understanding of *Syntax* and *Semantics* in our perception of language. The issue compounds the matter of how we identify, measure and attribute mental intentionality to other mental states. Some argue that intentionality is an intrinsic feature of any physical system which exhibits internal bodily casual connectivity and external connection to the world. Such a view or theory of consciosuness, could actually easily justify itself, even without resorting to any external independent interpretation (Searle, 1983).

The Rational Argument: Philosophical discussion and interpretation of Aristotle's works took place in the Medieval and Renaissance times. Those discussions influenced our views of rationality as being the dominant factor over ethical criteria about the moral treatment of animals. The result suggest: that humans predominantly have used arguments of difference between attribution of meaning to human rationality, not arguments of the irrationality of animals to justify our description of our own consciousness and animals' lack of it.

This raises a host of issues if we incorporate intentionality in self-perception and rationality in phenomenal consciousness. Terry Horgan (2013) speaking on Searles idea of necessary objects for consciousness stated *“... the real morality of Searle's Chinese Room thought experiment is that genuine original intentionality requires the presence of internal states with intrinsic phenomenal character that is inherently intentional…”*

Contrary to this position, David Hume (1711-1776) wrote that *“No truth appears to me more evident, than the claim that beasts are endowed with thought and reason as well as men”* (Jamieson, 1998). For all intent and purpose, Hume made a distinction between knowledge that we can acquire either through “impression” or “ideas”. Accordingly, for him, any metaphysical imagination we may have, is characterized by its demand to claim something about what's real, while simultaneously not being able to return to any internal or external impressions that we may have. For Hume then, a clear relation between cause and effect is not claimed. His statements on the subject regards’ epistemology and not ontology. Hume felt that there is no reason or rational intuition that can give us access to necessary and unchangeable principles of nature. There can therefore neither be any type of rationality that may give us universal normative morals. His conclusion was: that everything we can know about causality, is based exclusively on our own experience and sense data (Skirbekk and Gilje, 2007: 243-249).

The Linguistic Argument: The point of distinction that has been exhaustively defended, as being exclusively human, has as previously mentioned been the ability of usage of symbolic communication and language. Humans are supposedly the only species capable of such a complex task. This is the basis of arguments against animal rights that falls under the umbrella of *Contractualism.* This idea is: that human beings enter in a contract with one another, and all members of the contract need to be able to understand and agree to the terms of the contract. Therefore, by having a linguistic system, like ours, would necessarily exclude other animals from communicating or agreeing about anything at all with us. If they're not part of the contract, then we don't owe them anything.

The issue of nonverbal research methods in experimentation of non-human consciousness, has naturally been met with much controversy (Horschler et al. 2020).

Such experiments imply; that knowledge and belief representation in animals yields no real connection to the real world by virtue of their non-representational nature. The issue therefore very much complicates the development of a correct philosophy of mind for dealing with the consciousness of nonverbal infants and of non-human animals (Rakoczy, 2011).

The Chinese Room Argument: The Chinese Room Argument was proposed by John Searle in 1980. The proposition follows from the argument, that for a mind to have intelligence, it must first have understanding. The argument described Searle in a room using a computer program that responds to Chinese messages slipped to him under the door. Following instruction from the computer program, on how to reply to the messages by interpreting the symbols and numbers on the messages, he manages to reply with appropriate Chinese characters to the other side of the door. This implies that the receiver on the other side of the door could be mistaken in thinking a Chinese person is on the other side writing to them.

Based on the logic of his argument, Searle concluded: that computation, or syntax of a language is "observer-relative", and not to be mistaken for a feature of reality. *"Computation exists only relative to some agent or observer who imposes a computational interpretation on some phenomenon. This is an obvious point"* (Searle, 2002).

The Chinese Room Argument ascertains; that neither behavioral or non-verbal tests can justify whether we can attribute cognition to non-human animals (or computers) based soley on our own capability to imagine the mental states of others.

> *"In 'cognitive sciences' one presupposes the reality and knowability of the mental in the same way that in physical sciences one has to presuppose the reality and knowability of physical objects"* (Searle 1989).

The question of language and understanding, and their contribution to, and influence of the brain, is investigated in split-brain experiments which suggest that there can be two centers of consciousness, i.e. two distinct minds in one person. Despite having two brain hemispheres that both comprehend language, it is our left hemisphere which is responsible for the production of language (Dehaene, 2017). As the mind obviously has communication networks between the two sides of the brain, in some or another manner, a casual relation arises as to how the computation of syntax also gives rise to an understanding of semantics. The relation between mental states and self-perception, implies a complex causal biological dependency between the perception of semantics and its necessary role in affirming mental states in humans.

Furthermore, we find an analogous interpretation in the cross-section between describing measuring systems and communication systems in terms of the so-called "information-theoretic" view of measurement set forth by Claude Shannon and Warren Weaver in their book "The Mathematical Theory of Communication" published in 1963.

According to some scholars like Ludwik Finkelstein and Luca Mari, *Information Theory* should be combined with *Measurement Theory* as both focus on mapping. The first focuses on mapping between symbols in input and output signals, the second focuses on mapping between objects and numbers. This solution can give the analogy; that measurement per say is functionally equal to symbol-manipulation which in turn provides us with both a formal system of syntax and formalization computation of an inherent understanding of the semantics.

Higher Order Theory: According to some scholars like Peter Carruthers, a *Higher Order Thought* theory of consciousness, a theory of mind, is necessary to be present in the mind of an animal if we are to be able to argue that the animals have consciousness. According to this view, a *Higher Order Thought* theory is a prerequisite to phenomenal consciousness and therefore, if present, also grants an animal a higher order perspective of one's own thoughts (Carruthers and Gennaro, 2001).

For scientific simplicity, according to Occam's razor, this implies a plurality of thought objects which are deemed as not being necessary as per principle.

According to Immanuel Kant (1724-1804) an objective world is required for self-consciousness to transcend its own perspective and be able to grasp the difference between one's own (subjective) experience and the (objective) totality of experiences it is a part of (Strawson, 2018; Bennett 1966). In case of Higher Order Thought (HOT) theories, they suggest an ephemeral non-physical higher order state composed of thoughts and beliefs (Rosenthal, 2005; Carruthers, 2000). On the other hand, a higher order state which is composed of only self-reflexive perceptual sensory states becomes more self-aware according to Higher Order Perception (HOP) theories (Armstrong, 1993; Lycan, 2000).

Hence the question is raised: if self-consciousness is a necessary condition of intentionality and rationality and a required feature of a higher order mental state?

Many philosophers indeed argue that rationality requires self-knowledge which also itself implies self-consciousness (Mcdonald, 1999; Burge 1996; Bilgrami, 2012). Other scholars even claim that autistic people lack a theory of mind; this claim seemingly pervades modern psychology while still other research concludes that such claims are understandably societally harmful (Levine, 2001; Kriegel et al. 2006).

3 Discussion (i): The factual claim

According to *Environmental (Natural) Determinism,* the main factors affecting humans and our decisions are ecological, geographical and climatic. Likewise we must think of the same factors as determinants for animal cognition as access to food and shelter are highly determined by changing climate and weather conditions along with interspecies relations and their position in the food chain. Naturally, time and space become fundamental categories for any measurement of perception. Geography defines spatially how humans perceive the division between a subjective self-perceived, or a socially and culturally constructed understanding of space, scale, place, and territory. Accordingly, David Harvey, made three separations; an absolute, a relative and a relational understanding of space (Harvey, 2001). Hence, we can understand space as: (1) an objectively defined absolute surface where we can locate physical elements (Euclid, Isaac Newton, René Descartes), (2) a surface and location of elements that is relative to the observer and other elements (Albert Einstein, Carl Friedrich Gauss) and lastly (3) as a space that is defined by the relational aspect that is inherent in the objects or practices found in that space (Gottfried Leibniz), (Jordhus-Lier and Stokke, 2017).

In this regard it is prudent of us to acknowledge; that researchers most often, out of pure theoretical convenience and wish for simplicity, choose to either represent space by either employing Euclidean or non-Euclidean geometries, rarely is a relational space evoked.

Hence, if our experiences indeed reflect equally as much about the world, as they imply about our own being, a relational meaning perceived in our minds eye consequentially destroys the notion of *Realism* that reality resides outside in the world with us as mere spectators.

Scaling laws are mathematical tools available which we can use to describe living systems and how they respond to size changes to either any of their internal or external environments. Geoffrey West in his book "SCALE, The universal laws for growth, innovation, sustainability and pace of life in organisms, cities, economies and companies" (2018), explains how all organisms are ruled by a quarter-power scaling law. The fundamental observation of his work is; that many complex systems respond similarly to increases in size. Accordingly; *"if a mammal doubles in size (i.e. doubles its body weight), then its number of cells also roughly doubles, but its metabolic rate increases only by about 75%, rather than 100%."*

When we refer to biological systems and scaling that occurs in growth of physical organisms, we either make distinction between *allometric* scaling laws *(Describes how a change in one variable can lead to an enormous and disproportionate increase in another) or isometric* scaling laws *(Describes how proportional relationships are preserved as size changes).*

"The scaling law for metabolic rate, named as "Kleiber's law" (...), is valid across almost all taxonomic groups, including mammals, birds, fish, crustacea, bacteria, plants and cells" (West, 2017). Indeed research evidence already exists, that critical state dynamics in the brain follow power laws in the distribution of neuronal avalanches in superficial layers of the cortex (Klaus et al. 2011). As the discovery of allometric scaling laws gives very specific outcomes, the underlying regularity seems to suggest that we are observing a constrained mathematical evolutionary process which does not obey Darwin's *Theory of Evolution*. Evolution would have dictated: that the implicit nature of random processes does not allow an accumulation of consciousness to be distributed among living beings in a manner which does not support the principles of natural selection. As such, the current prevailing view in *Quantum Mechanics* implies that any physical system evolves as a superposition in time and space and only changes when observed whereby the «wave function collapses».

Our interpretation and measurement, due to the role of *Quantum Mechanics* thus becomes heavily reliant on an adequate differentiation between a predictable and deterministic outcome, or an indeterministic and random unpredictable outcome as per the *Copenhagen Interpretation* (Stanford Encyclopedia of Philosophy).

The mathematical formalism in *Quantum Mechanics*, which lacks a clear description of the purpose and nature of the wave function itself, raises the possbility that scaling laws might add the missing piece of information we need. This means that simple regular phenomena, which should not be present in such rich expressions that humans and animals exhibit, can show us a way to quantify non-human animal consciosuness.

Discoveries made by prominent physicists, in the eighteen and nineteen centuries, strengthen the view of power laws as being the hallmark of complexity. The major turning point in this subject was initiated by Carl Friedrich Gauss (1777-1855) through Gaussian geometry study of curves and surfaces in three dimensional Euclidean space. Although it may not be evident, the discoveries made by Gauss should have an enormous impact on our considerations of animal consciousness. His postulate; that a measurment of any value will yield a normal distribution (a bell shaped curve) with equal numbers of measurement on both sides of the mean value, has become the hallmark of statistical mathematics which effectively can approximate correlations between any natural phenomena.

Intuitively, we can indeed consider Gaussian distributions as an expression of some kind of universal law of nature, and of society, and not exclusively as only a tool that helps us characterize the probability of any event.

It is vital to mention; that Gaussian functions are not only widely used in statistics to describe normal distributions among the many things it also describes. It also describes the function of heat engines, these are systems that can convert heat to mechanical energy and make it available to do mechanical work. This is of course the reversed description of all biological living things. Additionally, relevant to this matter, is the fact that the Schrödinger equation which describes the evolution of the wave function also can be regarded as a heat equation in imaginary time.

In this regard, we cannot bypass the role that is played by normal (Gaussian) distribution and power law distributions in our measurement of consciousness that may show it to be an emergent feature of the Universe.

On one hand it is argued; that events and object sizes are dependent on statistical imprints of power laws. This view is credited to observations which point to power laws and their ubiquitous nature as being features of both natural and social systems. These power laws seemingly rely on some form of underlying self-organizing and mechanistic feature of all complex systems. Such relations, between power laws that arise in different biological or physical mechanisms, seem to show that an ontological connection exists between unrelated complex phenomena and that they may share a common source of origin.

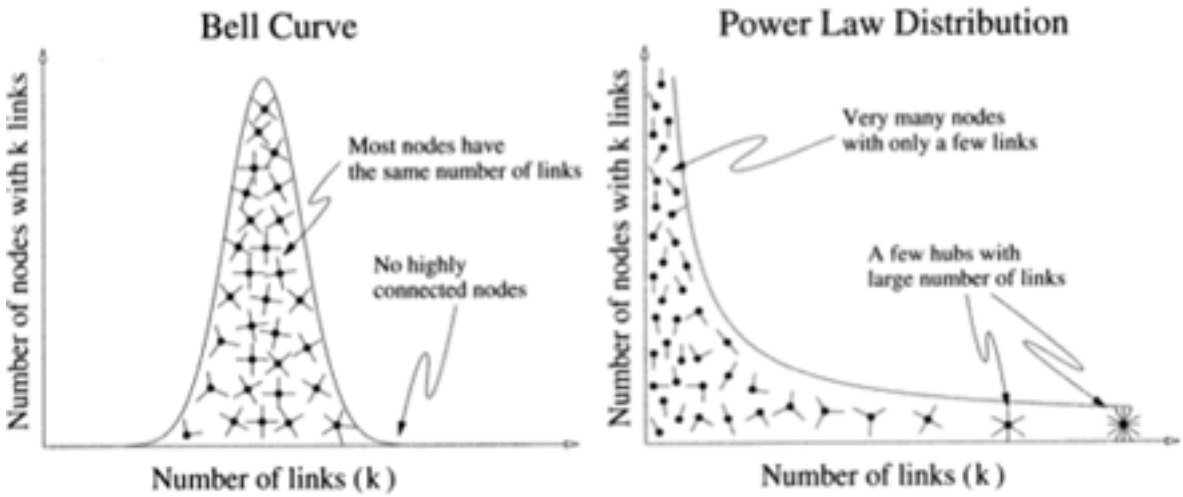
On the other hand others argue; that despite the appearance of power law distributions, as a sign of self-organized criticality of complex systems, notwithstanding many natural non-self-organizing mechanisms have been found which do not follow any power law distribution.

Hence, it is now believed: that most complex systems exhibit rare or sudden critical phase transitions on time scales much shorter than we logically would expect to see from evolutionary parameters of natural election and survival fitness alone. Such events imply; that there are underlying non-random forces which are hidden, but which remain crucial to our understanding of consciousness as a complex dynamic system.

Research pointing to the brain as being in a perpetual state of criticality on the “edge of chaos” between order and disorder is now gaining attention. It is said that criticality *"would allow us to switch quickly between mental states in order to respond to changing environmental conditions"* (Kitzbichler et al. 2009).

Such a view, contradicts that the brain works predominantly through inputs and outputs analogical to computational systems, rather it suggests consciousness is the result of the brain hovering in between chaotic points of order on the one side and randomness on the other implying that criticality offers a *"desirable trade-off between linearity, optimal for information storage, and nonlinearity, required for computation"* (Ravisetti, 2022). The subject of power laws has also been highlighted by statistical physicists who suggest that such laws emerge at this critical point of separation between the pre- and post-transition of such critical phases. Their claim is; that such events, as they approach a state of criticality in complex thermodynamic systems, demonstrate the existence of *Universality* in scaling behaviors which share the same fundamental properties.

Furthermore, criticality elaborates on how a difference in our statistical estimations either give rise to *exogeneity versus endogeneity* when considering self-organized criticality in social and natural sciences. The difference makes it difficult to assess, whether we can have confidence that critical events are in fact due to endogenous internal self-organization in the observed biological systems, or if the effects can be ascribed to exogenous external environmental variables. Understanding this issue is necessary if we are to have a clear description of the external and internal dependence of variables that impact the evolution and distribution of consciousness (Sornette).



(Image courtesy of Albert-Laszlo Barabasi, "Linked: The New Science of Networks")

Factually as a rule of thumb, we see Gaussian distributions drop-off sharply from the top which implies that large events are rare in the lower tails, opposingly, a power law distribution has an extended drop-off which is less sharp which implies that large events are more likely to happen (in the tail), this has colloquially given power laws the nickname of being “heavy-tailed” distributions. The mechanism dictates, if the outcome of an event follows a normal or power law distribution, is determined by the variable of interest that we try to measure.

If the factors that affect the variables are *additive* (constant effect regardless of other factors) it is expected that a bell-shaped curve will appear in our measurement. Otherwise, if *multiplicative* factors (scale invariant and proportional to other factors) affect the variables, we should then expect to see a power law distribution.

The scaling of metabolism is assumed to be a fundamental factor in ecology, *Metabolic Theory of Ecology* states that resting metabolism of an organism is controlled by body mass and body temperature (Gillooly and Brown, 2001; Brown, 2004). Studies in this field have mostly focused on either resting metabolism or body temperature, evaluation of both has been done by (White and Seymour, 2005) who concluded from an extensive data set for mammals and demonstrated a positive relationship between the two variables.

Studies have also shown that there is a strong functional relation between ecology, metabolic rate and body temperature, and that such features are present in both endotherms and ectotherms (Lovegrove, 2000; White et al.; Mcnab, 2005; Duncan et al., 2007).

As we now see, the behavior of animals are shaped by several factors, reproduction, predator-prey interactions and mortality which affects the ecology of dependencies of an organisms, and thermodynamic laws which govern our metabolic energy consumption and transformation.

Obviously, these factors become affected by the measurement problem through *Heisenberg's Uncertainty Principle* which exposes the failure to accurately measure microscopic superpositions of particle energies which depend on time, and their position which is dependent on their momentum, both affecting our understanding of *Statistical Mechanics*.

Our challenge becomes to specify what exactly the role of an observation is in measurement. Relying on some form of signals coming from the observed object to our measurement device creates unnecessary confusion towards the more important issue of how we use statistical and theoretical models to find possible relations between observed objects of interest and our empirical data.

Body mass and metabolic rates act as constraints on the ability for any animal to process high temporal resolution in its sensory perception (Healy et al. 2013). Findings illustrate that physiology and body mass, together with a beings thermodynamic environment impacts an animal's ability to resolve fine timescales in temporal features of its environment.

If fundamental constraints exist on evolutionary sensory perceptual adaptionation, then it is logical to think that these constraints also can be affecting the evolution of animal consciousness in general. Body size and metabolic rate seemingly shape the trade off and cost benefits of the resolution of the sensory system and an animal's ability to interact with its environment on short timescales.

Tracking fast and moving objects in space and time visually, is a common intuitive perception found also in human sight. Temporal resolution plays a key role in ecological and biological ability of all species. Some animals, due to many ecological, environmental and intrinsic factors, trade-off high temporal resolution with lower energetic metabolic demand resulting in lower neural and visual processing (Laughlin, 2001).

Perceptual difference between animals thus arises by differing the *"maximum rate of temporal information processing in the visual system".* Animal visual systems hence works as a gateway to a temporal multidimensional environment, where *relative* visual resolution constrains how organisms can process and interact with visual information. The reasoning goes: that rapid behavioral response favors perception of finer temporal timescales. Larger bodies have lower metabolic rate which decreases maneuverability. Hence, lower maneuverability equates to lower levels of processing of information (time goes slower) and vice versa for more agile bodies. Analysis of a wide range of vertebrates supports this hypothesis by using the critical flicker fusion frequency (CFF): the lowest frequency of flashing at which a flickering light source is perceived as constant in non-human animal perception (B. D'eath, 2001).

In recent few decades we find that Karl Friston has asserted the *Bayesian Brain Theory* as a fourth branch of physics and as a mathematical foundation for Neuroscience i.e *Bayesian Mechanics*. This framework is a paradigm shift that supports the idea that consciousness and cognition is embodied and can be described in cybernetic terms or as an autopoietic system which can produce and reproduce its own elements and structures. This is a system which exerts predictive control on its external environment. Following this explanatory mode of cognition, the brain attempts to anticipate and continually predict its external inputs and states of environment to reach swift habitual reactions. Only when unexpected prediction errors occur does it need to attend to its formation of a new response which implies the output constraints and directs the input. This Bayesian process concludes; that the brain maps out reality not as it objectively is, but rather at the very specific moment of manifestation when we impose our intention and action upon its unfolding (Friston, 2009). We thus must ask: if Thomas Kuhn was wholly correct in his assumption that *"The road from scientific law to scientific measurement can rarely be travelled in the reverse direction"* (Kuhn, 1961). If the *Bayesian Brain Theory* offers us a new path of acceptance of *Idealism,* then reality as perceive it, might in fact partly or wholly be created by our mind as the architect of our experiences.

4 Discussion (ii): The normative claim

Research that is done on animal consciousness (regardless of measurement methodology) tries to avoid anthropomorphism. Attributing human characteristics to animals has the effect of limiting research of non-human animal cognition to the issue of behavior. This effect problematically removes ties between biological and ecological causality and argues that animals do not have personal agency over their environmental and biological factors.

Perceptualism argues that through common sense, it is an act of intuition on the part of humans to attribute mental states to animals. A crucial point here is how trustworthy these pre-theoretic intuitions are about the minds of animals. According to *Perceptualism* there is in fact direct perception of (at least some) mental states of others. The implication being; that when we observe the mental state of others it becomes a part of our own perception, an explanation which indeed agrees with the quantum description of particle entanglement.

Opposing this view, is *Inferentialism* which claims; that we truly only can perceive behaviors which we must attach to our own rational inferences if we are to know of other mental states (Roelofs). As the nature of consciousness is abstract, researchers rely heavily on thought experiments; these largely disagree on many fronts regarding how language creates meaning and affects consciousness.

Opposingly, our assumption has indicated: that the physicalist account of consciousness wrongly rests on the conclusions that phenomenal consciousness can be attributed to physical and physiological properties of the neurons in human brains, but not the brains of animals.

Knowing the mental states of others: According to Konrad Lorenz, it should be possible to study (external) animal behavior on equal footing as evolutionary biology does with our (internal) bodies. He proposes; that we should be able to *"derive the phylogenetic relations among species by comparing their instinctive behavioral repertoires"* (Lorenz, 1971). *Cognitive Ethology,* according to Donald Griffin, includes the view defined as *"The subjective state of feeling or thinking about objects and events"* (Griffin, 2001). Indeed, we admit; that such a subjectivist position based on phylogenetics, can yield us a framework for distribution of consciousness so that even insects are conscious as they, albeit less than humans, also exhibit some anthropomorphic traits like reproduction and nurturing.

The complex description of animal consciousness follows; that not only does it exist, but that it also has knowledge of other minds and naturally also is self-aware. This picture of contemporary *Simulation Theory* implies that humans can subjectively attribute mental states to other living beings (Heal, 1986; Goldman, 2008). Consciousness then, by agency of its own virtue as a sentient self-perception, must exhibit a casual biological and physical frame of reference. A variable of consciousness, with such properties, should be measurable (Andrews et al. 2018; Wilcox, 2020).

Subjective nature of the mind: A distinction between phenomenal consciousness and sentient self-consciousness is crucial. The former, includes the subjective experience of the mind, the qualitative conscious experience usually called "qualia", the latter is a hallmark of all consciousness. Some philosophers regard animal sentience in terms of their lack of phenomenal consciousness yet they rarely make a distinction from that to self-consciousness.

Thomas Nagel (1974) wrote the phrase; *"something it is like",* as to what it means to be a member of another species. Through saying so, Nagel disputes that humans can have the capacity to describe or even imagine what it is like to be a bat. Yet indeed, he also assumes that there is something it is like. The distinction between phenomenal consciousness and sentient self-consciousness as such reveals; that consciousness requires that one possess, or has a concept of one self. This requirement naturally and very problematically denies any sophisticated normative conceptual and unified stream of consciousness to infants and non-human animals as they do not seem to be self-aware at all (Bayne, 2004).

In his book *"*Principles of Psychology" (1890), William James proposed the idea that; differing intensities of conscious experience in fact exists across the animal kingdom.

Similarly, Conway Lloyd Morgan wrote in his 1894 textbook "An Introduction to Comparative Psychology", about his *Double Inductive* method for understanding the mental states of animals. His method was made up of inductive inferences on his observation of animal behavior, combined with introspective subjective knowledge of human minds. This was, according to him developed; because of the necessity to deal with the tendency of evolutionary psychology to exhibit anthropomorphic bias when considering non-human animals' consciousness.

Such views, Morgan argued; supported the Darwinian view of employing anecdotal evidence and arguments by analogy as evidence for mental continuity. *Morgan's Canon* then is a principle which states: *"In no case may we interpret an action as the outcome of the exercise of a higher psychical faculty, if it can be interpreted as the outcome of the exercise of one which stands lower in the psychological scale"* (Lloyd Morgan's Canon). The argument from analogy indeed has been the bedrock of opposition to animal cognition justified by the *Logical Empiricist* demand for rationality as a sign of higher order thought.

This dualistic account is normally taken to remove the requirement of knowing other minds as a mechanism for avoiding issues of solipsism which seemingly emerge in the philosophical discussion. This account was also shared by John Locke (1632-1704), who meant that we can only ever know the existence and content of our own minds, knowing of other minds was necessarily an indirect and analogical inference from "*our own cause",* and not from an external factuality about the minds of others.

Recognizing yourself, as distinct from your environment, and having perception of others, as separate beings from oneself, is key for self- perception. Concurrently, several species have been able to pass the *Mirror Test*, which means that these animals were able to recognize a mark on their body in the mirror, a sign of cognition of their own body being altered (Pachniewska).

Solipsistic Self-Perception: We also cannot ignore *Solipsism* as derived from the Cartesian account of dualism, it becomes a main issue of how we can know the experience of others and achieve objective certainty of any measurement. As we undoubtedly must come to recognize, there are specific theories and hypotheses which indeed may aid us in our investigation. Linguistic relativity, or the so-called *Sapir–Whorf hypothesis* implies that the language which living beings communicate in, influences the perceptual outcome of observing that being's own reality (Frothingham). Even though Descartes objected to giving animals the capability of thinking, he notwithstanding agreed with Aristotle on aspects of continuity of the mind and his conception of the soul (Muratori 2019).

As a valid conclusion from the premise, the observation of others, in Cartesian terms, is said to be inherently egocentric, subjective, and restrained from conceptualizing other animal minds "from our own cause", there's no escaping this fact.

These issues raise critical epistemological questions on the limits of our knowledge and of the ontological foundations of the scientific method.

Furthermore, the difference between *Cognitivists* and *Non-cognitivists* also highlights how arguments and value-statements on animal cognition are meaningful, despite the risk of lacking a truth value (Stanford Encyclopedia of Philosophy).

Our research followingly agrees with the view of *Perspectivism*; that the complexity of mental states requires us to interpret value statements as imperatives or moral commands, so that we can clarify how natural and cognitive sciences can and may, converge empirically.

It appears that humans wrongly not only reject the attribution of mental states to animals based on phenomenal arguments, but that we also make the wrong axiological distinction between the notions of *intrinsic* and *extrinsic* values in ethical values of animal rights.

Despite a need to agree on a definitive proposition on the moral status of animals, the cultural context of moral frameworks of different societies due to *Cultural Relativism* continues fundamentally to prohibit us from such futile ethical-normative attempts.

3 Conclusion

Our research, although inconclusive, has identified the need for additional research which is needed to clarify how exactly biological and physical mechanisms play a role in ecological functioning of animal perceptual senses and the emergence of consciousness. Upholding a certain level of determinate and immediate teleology also agrees with citations concerning its part in scientific endeavors (Barrow and Tipler, 1986).

An accurate description of the underlying quantum fabric of spatial and temporal space in complex systems, would probably lead us to a formalized quantification of consciousness. How new research will define the quest for animal consciousness, still remains at the mercy of Occam's razor. It is to blame for enabling Einstein's *General Relativity* and Newton's (simplistic) views on the Universe which have resulted in a "view from nowhere" account of how reality can exist (and function) without a guiding consciousness (Jurgenson).

Notwithstanding their misconceptions, these views may be alleviated through their deterministic implications whereby acknowledging the ideas of Baruch Spinoza (1632-1677) of our minds being an interdependent organism interconnected with the entirety of existence. This yields us a causal framework of ecologic simultaneity of events in both matter and mind supervening through a third substance namely *Neutral Monism*.

The biological levels of function at sub-neuronal levels, in a solipsistic reality, requires us to accept a certain indeterministic epistemic position while still forcing us to interpret *Locality and Rrealism* in a physical casual sense because of Einstein's *Special Relativity*. The measurement of outcomes that are based on probabilities; in observer dependent theories of quantum states, thus yield us with a route of further investigation to settle the subjectivist requirement of *Solipsism*.

Quantum Bayesianism or "QBism" (pronounced as "Cubism") logically becomes our necessary interpretation. It places the action and experiences of an agent as the main central proposition of how the wave function really works, and how we can describe our individual subjective self-perception without resorting to knowing the mind of others. The Schrødinger equation, which governs the temporal evolution of the wave function, is accordingly not to be treated as real, Qubism rather implies that it only describes our own subjective mental state and not the true nature of reality presuming we don't update our information continually (Gefter).

Understanding the metaphysics of scientific laws and objective probabilities remains an open question. We can either take an anti-Humean account, and state that natural laws are governing physical events, or we can settle with the Humean account: that laws only describe patterns and regularities. As we have clearly observed patterns in our data, that both comply with and yet contradict evolutionary and mathematical laws. We now collectively must manage to commensurate between the ambiguity of epistemic subjectivity of our evaluative concepts, and the ontological subjectivity of our deontic concepts if we are ever able to confirm the famous statement of John Archibald Wheeler*: "All things physical are information-theoretic in origin and this is a participatory universe… Observer-participancy gives rise to information."*

It may very well be, after all, that humanity is able to ascertain that consciousness creates reality, that it indeed collapses the wave function. Yet believing that humans are the pinnacle of creation in an anthropocentric Universe, and the most conscious species of all because we are also the most materially dependent, this might very well be the greatest delusion and logical fallacy of all time. Not only are we the most self-destructive in relation to the ecosystems that we exploit and depend on, but we are also simply outmatched by bacteria and animals by sheer biomass which has existed on Earth for far much longer. If their combined perceptual observance ability of reality is added up, their consciousness is unfathomable, this is the nature of the beast!

4 Literature and bibliography

Andrews, Kristin, et al. *Chimpanzee Rights: The Philosophers' Brief*. Routledge, Taylor & Francis Group, 2018.

Armstrong, David Malet. *A materialist theory of the mind*. Routledge, 1993.

Avramides, Anita. *Other Minds*. Routledge, 2001.

Baggini, Julian. "Julian Baggini, Morality as a rational requirement." *PhilPapers*, https://philpapers.org/rec/BAGMAA.

Baluška, František, et al. "Biomolecular Basis of Cellular Consciousness via Subcellular Nanobrains." *International Journal of Molecular Sciences*, 2021.

Barrow, John D., and Frank j. Tipler. "A place for teleology?" *Nature*. *Nature*, https://www.nature.com/articles/320315a0.

Bayne, Tim. "Self-Consciousness and the Unity of Consciousness." *Jstor*, 2004.

B. D'eath, Richard B. "Can video images imitate real stimuli in animal behaviour experiments?" *Biological Reviews*. *Online Library*, https://onlinelibrary.wiley.com/doi/10.1111/j.1469-185X.1998.tb00031.x.

"Beats per life." *Rob Dunn Lab*, 28 June 2017, http://robdunnlab.com/projects/beats-per-life/literature-search-tips/.

Bennett, Jonathan, and Jonathan Francis Bennett. *Kant's Analytic*. Cambridge University Press, 1966.

Bilgrami, Akeel. *Self-Knowledge and Resentment*. Harvard University Press, 2012.

Block, Ned, editor. *Readings in Philosophy of Psychology, Volume I*. Harvard University Press, 2013.

Brown, James H. "TOWARD A METABOLIC THEORY OF ECOLOGY." *Ecological Society of America*, 2004, https://www.esa.org/wp-content/uploads/sites/94/2022/02/Brown_JH_MA.pdf.

Bruce, James. “Nagel's Cosmos: Teleology Without Intention?” *Law & Liberty*, 22 December 2013, https://lawliberty.org/book-review/nagels-cosmosteleology-without-intention/.

Burge, Tyler. “ur Entitlement to Self-Knowledge: II.” *Proceedings of the Aristotelian Society*. *Jstor*, https://www.jstor.org/stable/4545231?casa_token=FpBtD2Nosr8AAAAA%3ACUgTE3rsAXAWzEF4r7NF8ZeX52OmhtVXi0HQT9bnvW4n21Aw-a6SMaxsEX1kgG0QTiw7A00hBE4T4mqjrnXYajnmNiDWEL0PMT6ys9dMmPHNKPA&seq=1.

Carruthers, Peter. “Peter Carruthers, Phenomenal Consciousness: A Naturalistic Theory.” *PhilPapers*, https://philpapers.org/rec/CARPCA-12.

Carruthers, Peter, and Rocco Gennaro. “Higher-Order Theories of Consciousness (Stanford Encyclopedia of Philosophy).” *Stanford Encyclopedia of Philosophy*, 3 April 2001, https://plato.stanford.edu/entries/consciousness-higher/.

Clarke, Andre Clarke, and Peter Rothery. “Scaling of body temperature in mammals and birds.” *British Ecological society*, https://doi.org/10.1111/j.1365-2435.2007.01341.x.

Daniel C. Dennett, Animal Consciousness: What Matters and Why Social Research. Vol. 62, No. 3, In the Company of Animals (FALL 1995), The Johns Hopkins University Press

Dawkins, Marian Stamp. *Why Animals Matter: Animal Consciousness, Animal Welfare, and Human Well-being*. Oxford University Press, 2012.

Dehaene, Ghislaine. “The human infant brain: A neural architecture able to learn language.” *NCBI*, 2017, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5433546/.

Duncan, Richard P., et al. “Testing the metabolic theory of ecology: allometric scaling ...” *Welcome to University of Canberra Research Portal*, https://researchprofiles.canberra.edu.au/en/publications/testing-the-metabolic-theory-of-ecology-allometric-scaling-expone.

Farah, Martha J. “Environmental stimulation, parental nurturance and cognitive development in humans.” *Developmental Studies*. *Onlinelibrary.wiley.com*, https://onlinelibrary.wiley.com/doi/10.1111/j.1467-7687.2008.00688.x.

Faye, Jan. “Copenhagen Interpretation of Quantum Mechanics (Stanford Encyclopedia of Philosophy).” *Stanford Encyclopedia of Philosophy*, 3 May 2002, https://plato.stanford.edu/entries/qm-copenhagen/.

Friston, Karl. “The free-energy principle: a rough guide to the brain?” *The Wellcome Trust Centre for Neuroimaging,*

Frothingham, Mia Belle. “Sapir–Whorf hypothesis (Linguistic Relativity).” *Simply Psychology*, 14 January 2022, https://www.simplypsychology.org/sapir-whorf-hypothesis.html.

Geoffrey B. Wes, t Scale: The Universal Laws of Life, Growth, and Death in Organisms, Cities, and Companies. Penguin Books, May 15, 2018

Gefter, Amanda. “A Private View of Quantum Reality.” *Quanta Magazine*, 4 June 2015, https://www.quantamagazine.org/quantum-bayesianism-explained-by-its-founder-20150604/.

Gillooly, Jamie, and James Brown. “Effects of size and temperature on metabolic rate.” *PubMed*, https://pubmed.ncbi.nlm.nih.gov/11567137/.

Goldman, Alvin I. *Simulating Minds: The Philosophy, Psychology, and Neuroscience of Mindreading*. Oxford University Press, 2008.

Griffin, Donald R. *Animal Minds: Beyond Cognition to Consciousness*. Edited by Donald R. Griffin, University of Chicago Press, 2001.

Harvey, David. *Spaces of Capital: Towards a Critical Geography*. Routledge, 2001.

Heal, Jane. *Fact and meaning : Quine and Wittgenstein on philosophy of language*. B. Blackwell, 1989.

Healy, Kevin, et al. “Metabolic rate and body size are linked with perception of temporal information.” *Animal Behaviour*. *Science Direct*, https://www.sciencedirect.com/science/article/pii/S0003347213003060?via%3Dihub#bib53.

Horschler, Daniel J., et al. “Do Non-Human Primates Really Represent Others’ Beliefs?” *Trends in Cognitive sciences*, 2020. *Researchgate*, https://www.researchgate.net/publication/342426585_Do_Non-Human_Primates_Really_Represent_Others'_Beliefs.

Jamieson, Dale. “Science, Knowledge, and Animal Minds.” *Arts & Science*, 8 December 1997, https://as.nyu.edu/content/dam/nyu-as/faculty/documents/JAMIESON_Knowledge-and-ANIMAL-MINDS_1998.pdf.

Jorgensen, Larry M. “The principle of continuity and Leibniz's theory of consciousness.” *Journal of the History of Philosophy*, 2009.

Jurgenson, Nathan. “View From Nowhere – The New Inquiry.” *The New Inquiry*, 9 October 2014, https://thenewinquiry.com/view-from-nowhere/.

Kitzbichler, Manfred G., et al. “Broadband Criticality of Human Brain Network Synchronization.” *PLoS Computational Biology,* 2009.

Klaus, Andreas, et al. “Statistical Analyses Support Power Law Distributions Found in Neuronal Avalanches.” *PLOS ONE,* 2011

Kriegel, Professor of Philosophy and Cognitive Science and Associate Director of the Center for Consciousness Studies Uriah, et al., editors. *Self-representational Approaches to Consciousness*. MIT Press, 2006.

Kuhn, Thomas S. “The Function of Measurement in Modern Physical Science | Isis: Vol 52, No 2.” *The University of Chicago Press: Journals*, https://www.journals.uchicago.edu/doi/abs/10.1086/349468. Accessed 22 April 2022.

Laughlin, Simon B. “Energy as a Constraint on the Coding and Processing of Sensory Information.” *Current Opinion in Neurobiology*. *Researchgate*, https://www.researchgate.net/publication/11843325_Energy_as_a_Constraint_on_the_Coding_and_Processing_of_Sensory_Information.

Levine, Joseph. *Purple Haze: The Puzzle of Consciousness (Philosophy of Mind Series)*. Oxford University Press, 2001.

“Lloyd Morgan's canon.” *Oxford Reference*, https://www.oxfordreference.com/view/10.1093/oi/authority.20110803100110842. Accessed 4 April 2022.

Lorenz, Konrad. *Konrad Lorenz: Studies in Animal and Human Behaviour. Volume II*. Translated by Robert Martin, Harvard University Press, 1971.

Lovegrove, Barry. “The Zoogeography of Mammalian Basal Metabolic Rate.” *The American Naturalist*. *Researchgate*, https://www.researchgate.net/publication/12462862_The_Zoogeography_of_Mammalian_Basal_Metabolic_Rate.

Lycan, William G. *Philosophy of Language: A Contemporary Introduction*. Routledge, 2000.

Mari, Luca, et al. *Measurement Across the Sciences: Developing a Shared Concept System for Measurement*. Springer International Publishing, 2021.

Maudlin, Tim. “Computation and consciousness.” *The Journal of Philosophy*, 1989, https://home.csulb.edu/~cwallis/labs/stanford/Computation&consc.pdf.

Mcdonald, Cynthia. “Shoemaker on Self-Knowledge and Inner Sense.” *Philosophy and Phenomenological Research*, 1999. *Jstor*, https://www.jstor.org/stable/2653791.

Mcnab, Brian. “Uniformity in the basal metabolic rate of marsupials: its causes and consequences.” *Revista Chilena de Historia Natural*. *Researchgate*,

https://www.researchgate.net/publication/240841421_Uniformity_in_the_basal_metabolic_rate_of_marsupials_its_causes_and_consequences.

"Measurement in Science (Stanford Encyclopedia of Philosophy)." *Stanford Encyclopedia of Philosophy*, 15 June 2015, https://plato.stanford.edu/entries/measurement-science/.

Michell, John. "Epistemology of Measurement: The Relevance of its History for Quantification in the Social Sciences." *Social Science Information*, 2003.

Miłkowski, Marcin. *Explaining the Computational Mind*. MIT Press, 2013.

"Moral Cognitivism vs. Non-Cognitivism (Stanford Encyclopedia of Philosophy)." *Stanford Encyclopedia of Philosophy*, 23 January 2004, https://plato.stanford.edu/entries/moral-cognitivism/.

Muratori, Cecilia. "The Aristotelian Carnivore: The Ethical Afterlives of Aristotle's Theory of Animal Irrationality." *Revue des sciences religieuses*. *International Bibliography of Theology and Religious Studies*, https://ixtheo.de/Record/1687011710/Description#tabnav.

Nagel, Thomas. *What Is It Like to Be a Bat? / Wie Ist Es, Eine Fledermaus Zu Sein? Englisch/Deutsch (Was Bedeutet Das Alles?)*. Edited by Ulrich Diehl, translated by Ulrich Diehl, Reclam, 2016.

Pachniewska, Amanda. "List of Animals That Have Passed the Mirror Test." *Animal Cognition*, 15 April 2015, https://www.animalcognition.org/2015/04/15/list-of-animals-that-have-passed-the-mirror-test/.

Peat, David. "David Bohm, Implicate Order and Holomovement - SAND." *Science and Nonduality*, https://www.scienceandnonduality.com/article/david-bohm-implicate-order-and-holomovement.

Rakoczy, Hannes. “Do infants have a theory of mind?” *British Journal of Developmental Psychology*, 2011. *The British Psychological Society*, https://bpspsychub.onlinelibrary.wiley.com/doi/10.1111/j.2044-835X.2011.02061.x.

Ravisetti, Monisha. “Your Brain Operates at the Edge of Chaos. Why That's Actually a Good Thing.” *CNET*, 23 May 2022, https://www.cnet.com/science/biology/features/your-brain-operates-at-the-edge-of-chaos-why-thats-actually-a-good-thing/.

Roelofs, Luke. “Amodal Mind-Perception: Combining Inferentialism and Perceptualism - Minds Online.” *Minds Online*, 29 August 2015, https://mindsonline.philosophyofbrains.com/2015/session1/amodal-mind%C2%AD-perception/.

Rosenthal, David M. “David M. Rosenthal, Consciousness and Mind.” *PhilPapers*, https://philpapers.org/rec/ROSCAM-8.

Searle, John R. *Consciousness and Language*. Cambridge University Press, 2010.

Searle, John R. *Mind: A Brief Introduction*. Oxford University Press, 2004.

Searle, John R., and Willis S and Marion Slusser Professor of Philosophy John R. Searle. *Intentionality: An Essay in the Philosophy of Mind*. Cambridge University Press, 1983.

Singer, Peter. *Animal Liberation: The Definitive Classic of the Animal Movement*. HarperCollins, 2009.

Singer, Peter, and Tom Regan, editors. *Animal Rights and Human Obligations*. Prentice Hall, 1989.

Skirbekk, Gunnar, and Nils Gilje. *Filosofihistorie: Innføring i europeisk filosofihistorie med særlig vekt på vitenskapshistorie og politisk filosofi*. Translated by Torgeir Ulshagen, Universitetsforlaget, 2007.

Sober, Elliott. *Philosophy of biology*. Avalon Publishing, 2000.

Sornette, Didier. “Probability Distributions in Complex Systems.” *arxiv*.

Strawson, Peter. *The Bounds of Sense: An Essay on Kant's Critique of Pure Reason*. Translated by Lucy Allais, Routledge, 2018.

Suppes, Patrick. *Studies in the Methodology and Foundations of Science: Selected Papers from 1951 to 1969*. Springer Netherlands, 1969.

"What is the total weight of all the animals on Earth?" *World Economic Forum*, 25 August 2021, https://www.weforum.org/agenda/2021/08/total-biomass-weight-species-earth.

West, Geoffrey B. *Scale: The Universal Laws of Growth, Innovation, Sustainability, and the Pace of Life in Organisms, Cities, Economies, and Companies*. Penguin Press, 2017.

White, Craig R., et al. "The scaling and temperature dependence of vertebrate metabolism | Biology Letters." *Journals*, https://royalsocietypublishing.org/doi/abs/10.1098/rsbl.2005.0378.

White, Craig Robert, and Roger Seymour. "Allometric scaling of mammalian metabolism." *Journal of Experimental Biology*, 2005, https://www.researchgate.net/publication/7883405_Allometric_scaling_of_mammalian_metabolism.

Wilcox, Marc G. *3The Intrinsic Value of Liberty for Non-Human Animals*. 2020, https://www.researchgate.net/publication/345999420_The_Intrinsic_Value_of_Liberty_for_Non-Human_Animals.